TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

04th April 2014

1. INNOVATIVE ROBOTIC SYSTEM FOR ANALYZING 3D OBJECTS

Indicative of the plethora of applications, and the expanding opportunities for robotics, researchers at the Georgia Institute of Technology (United States) have developed an innovative robotic system for simulating and analyzing the chemical reactions of early Earth on the surface of rocks. In an experiment that was conducted by the researchers, a region in a round or irregularly shaped object was selected for analysis using a three-dimensional (3D) camera that is fitted to the robotic arm. This robotic arm mapped the 3D coordinates of the sample object's surface that was being tested; the researchers had also programmed the robotic arm to poke the sample with an acupuncture needle. By poking the surface, the needle was made to collect a small amount of material, and then this material was deposited on a mass spectrometer for determining the chemical composition of the material. A mass spectrometer is a powerful tool for analyzing the surface chemistry of various objects and samples. It has been widely used for a range of research activities, but the samples for analysis have to be cleaned and prepared; for instance, in the case of rocks, it has to be cut into thin films. According to the researchers, this robotic system is capable of analyzing the 3D mass spectrometry of native surfaces. This research has been published in the February 2014 edition of the journal Analyst . The US National Science Foundation (NSF)'s Major Research Instrumentation Program (MRI) grant and the NASA Astrobiology Program, under the NSF Center for Chemical Evolution, are some of the key organizations that have supported this research. To further test the capability of the robotic system in analyzing the 3D object, the researchers imprinted ink patterns on the surfaces of polystyrene spheres. The robotic arm was then employed to model the surfaces, probing the specific

regions, and analyze if the samples collected were sufficient for mass spectrometry analysis. By doing this, the researchers were also able to detect links of various colors and create a 3D image of the object with sufficient sensitivity for establishing the proof of their principle.

According to the researchers, the initial findings have marked a significant development in the employment of robots for 3D surface experiments on geological material. Currently, the researchers are working on improving the accuracy of the robots thereby enabling them to be adopted for a wide range of potential applications in the biomedical field. To achieve the aforementioned capabilities, a new mass spectrometer has been adopted, which has a higher resolution than the one employed in the initial stages of the research.

The advantages of this robotic system are its capability to analyze irregular-shaped object in a 3D format and its potential for use in a wide and diverse range of applications.

Details: Brett Israel, PR contact, Georgia Institute of Technology, 177 North Avenue, Atlanta, Georgia 30332-0181. Email: brett.israel@comm.gatech.edu. Phone: +1-404-385-1933. URL: www.gatech.edu.

2. THERMAL INTERFACE CONDUCTING MATERIAL FOR A WIDE RANGE OF APPLICATIONS

Development of thermal management schemes are becoming increasingly challenging as devices become ever- smaller, Researchers form the Georgia Institute of Technology have developed a novel thermal interface material that could be used for drawing heat from electronic devices in servers, automobiles, high brightness LEDs and also from certain mobile devices. This material is fabricated on heat sinks and heat spreaders, thereby making it easy to implement in devices. The easy integration of this material in devices also reduces the reliability challenges that are caused due to differential expansion seen in thermal conducting materials currently available in the market. According to the researchers, this novel material could be very efficient in addressing the thermal management issues. In addition, it could also enable companies to design novel electronic systems. The research was published in the March 2014 edition of journal *Nature Nanotechnology* and has been supported by the National Science Foundation (United States).

The new thermal material is produced from a conjugated polymer, polythiophene, having aligned polymer chains in nanofibers that helps in the transfer of photons without causing brittleness in the crystalline structure. Formation of nanofibers also produces an amorphous material with thermal conductivity of 4.4 watts per meter kelvin at room temperature. This novel thermal material was tested at 200 degrees C, a temperature that would make this material useful in various vehicle applications. The structures of the material were grown in a multi-step process starting with an alumina template containing minute pores that are covered by an electrolyte. Whenever an electrical potential is applied to the template, electrodes present at base of each pore flow and form hollow nanofibers. The amount of electricity applied and the time of growth controls the length of the fibers and the thickness of the walls. The size of pores controls the diameter of the nanofibers. Once the monomer chains are formed, the nanofibers are cross linked with an electropolymerization process and then the template is removed. The resulting structure can then be attached to electronic devices or any other application for absorbing the heat. Researchers are currently working on further developing the thermal properties of this novel material; they also believe that this material could be scaled up in size for manufacturing and commercialization. The new thermal material is capable of allowing thermal interfaces that are as thin as three microns compared to the conventional materials, which allow as much as 50 to 75 microns. A patent has been filed for this novel material and the researchers have also started a startup named Carbice Nanotechnologies for commercializing their thermal interface technologies.

The advantages of this thermal material are that it has high thermal conductivity and can be easily integrated into small electronic devices. The other advantage is the significantly low cost compared to the other materials currently available in the market. The low cost of this novel thermal material is because of the thermal interface technology that the researchers have developed. Due to the above-mentioned advantages, this material and the technology used in developing the material have the potential to be significantly adopted, following commercialization.

Details: John Toon, PR contact, Georgia Institute of Technology, Georgia Institute of Technology, 177 North Avenue, Atlanta, Georgia 30332-0181. Phone: +1-404-894-6986. Email: jtoon@gatech.edu. URL: www.gatech.edu.

3. INNOVATIVE ROBOTIC SYSTEM FOR AIRCRAFT MANUFACTURING SECTOR

Indicative of opportunities for autonomous robots capable of working alongside humans, a novel mobile robot assistant is being developed for helping technicians produce components in the airplane manufacturing sector. This novel robot is designed for carrying out tasks, such as, measuring, testing, and applying sealants, without putting the human lives at risk.

This robot assistant is being developed through collaboration between Airbus DS, FACC AG, IDPSA, KUKA Laboratories GmbH, PROFACTOR GmbH, and Fraunhofer Institute for Factory Operation and Automation (IFF), the project's coordinator, under the EU funded project Validation of Advanced, Collaborative Robotics for Industrial Applications (VALERI). The robot is designed for operating autonomously and is capable of moving independently alongside technicians and engineers in a production plant and relieving them of monotonous stressful duties. When the assembly of fuselage elements is being carried out, large quantities of sealants are applied to the joints; mobile robots are well-suited to carry out this task. Mobile robots are more flexible and can be used at various stations of the production plant, at various speeds, performing functions such as delivering tools to the technicians from a warehouse or from different locations in the plant. In order to reduce the collisions between humans and the robots, the researchers have equipped the robots with mobile platform consisting of cameras and touch sensitive interfaces having a cushioning layer. The sensors attached to the robots act as an artificial skin, and by using this technology in combination with other optical sensors, it is possible to sense and avoid unintended collisions. For instance, if there is a contact, the robot stops immediately and moves in different direction. This robot also has a multi-extension arm possessing 12 degrees of freedom, which enables movement sideways, as well as, rotation of the robotic arm. One of the unique features of this robot is its ability to move the robotic arm at the same time as it moves. The prototype of this robot is expected to be completed by the end of this year and the tests under real-life conditions are expected to be carried out by October 2015. In the first test that is scheduled to be carried out, the robot is going to be made to move autonomously, identify real airplane elements, and solve the tasks without causing any risk to human lives. Some of the potential application sectors for this mobile robot are ship building and production of wind turbines.

This mobile robot has potential to change the production process in the aviation industry by accelerating the process and making it more flexible, in addition to relieving humans from carrying out complicated tasks. With its capabilities, this mobile robot can be well-suited for the factories of the future.

Details: José Saenz, Researcher, Fraunhofer Institute for Factory Operation and Automation IFF, Sandtorstraße 22, 39106 Magdeburg, Germany. Phone: +49-391-4090-127. E-mail: jose.saenz@iff.fraunhofer.de. URL: www.fraunhofer.de.

4. PATENT ANALYSIS OF PULTRUSION PROCESS

Pultrusion is a type of manufacturing employed for producing a continuous length of reinforced polymer shapes (such as, composite materials) having constant cross sections. The raw materials used in this process can include liquid resin mixture containing resin, fillers, and specialized additives, in addition to flexible textile reinforcing fibers. The pultrusion process involves pulling of the above-mentioned raw materials through a heated steel-forming die using a continuous pulling device. The reinforcement materials are in continuous forms, such as, rolls of fiberglass. As the reinforcement is saturated with a resin mixture in the resin bath and pulled through a die, the hardening of the resin is initiated by the heat that is produced from the die and a rigid cured profile of the raw material is formed corresponding to the shape of the die. Many types of pultrusion machines are available based on the size and shape of the products being manufactured.

From the patents that have been exhibited, it can be seen that the research has been carried out to enhance the pultrusion process for applications, such as, producing composite materials (including, carbon nanotube reinforced composites) or semi-finished products based on polymers.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
2-k pultrusion formulation and process	September 6, 2013/ WO 2013127850 A1	Bayer Intellectual Property Gmbh	Stephan Schleiermacher, Dirk Wegener, Harald Rasselnberg	A reaction system for the preparation of a fiber reinforced composite, comprising a continuous fiber reinforcing material and a polyurethane formulation comprising a polyisocyanate component containing at least one polyisocyanate and an isocyanate-reactivecomponent containing a blend of at least threepolyols.The invention further relates to a fiber reinforced composite which comprises a reaction system of the before mentioned type as well as a pultrusion process for the preparation of a fiberreinforced composite using the reaction system.
Reinforced composites produced by a vacuum infusion or pultrusion process	August 22, 2013/ US 20130216390 A1	Bayer Materialscience Llc	Usama Younes, Serkan Unal	Carbon nanotube-reinforced composites are produced by incorporating up to 0.7% by weight of carbon nanotubes into a liquid polymeric material a polymeric material. The viscosity of the carbon nanotube-containing liquid polymeric is sufficiently low that it can be used in vacuum infusion and pultrusion processes to produce large articles such as wind turbine blades.
Pultrusion Process for Preparing Composites Having Low Percentage of Fibers and Articles Made from Same	August 8, 2011/ US 20130204368 A1	Warsaw Orthopedic, Inc	Julien J. Prevost	An improved pultrusion process for preparing composite materials having about 10 percent to about 45 percent by volume of reinforcing fibers so as to produce a composite material having enhanced flexibility as compared with composite materials having a higher percent of reinforcing fibers by volume. Articles of manufacture made from composite material produced by the improved pultrusion process, specifically spinal implants, are also provided.
Release agent for pultrusion molding process of glass fiber reinforced plastic and preparation method thereof	June 5, 2013/ CN 101695860 B	Tianchang wide plexiglass Ltd.	Zhang month	The invention discloses a pultrusion process for FRP release agent and its preparation method is mainly based on the weight of the mixture is 60% alcohol, 20% to 30% of phosphorus pentoxide, 8% to 12% soya bean oil and 2% to 8% of silicone oil as a raw material, a method using a simple and easy to control, was prepared to obtain a resin matrix between different has good compatibility, and can improve the mechanical properties of the mold release agent, particularly suitable for FRP pultrusion process.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Pultrusion process for the manufacture of fiber reinforced composites	February 20, 2013/ EP 2301045 B1	Union Carbide Chemicals & Plastics Technology LLC	Buo Chen	This invention relates to fiber reinforced composites. In one aspect, the invention relates to a pultrusion process for fiber reinforced composites while in another aspect, the invention relates to the wet-out step of such a process. In yet another aspect, the invention relates to a pultrusion process in which the wet-out step employs a highly reactive epoxy resin system applied with a high-pressure spray nozzle while in still another aspect, the invention relates to such a wet-out step in which the filaments of the fiber are spread apart from one another before the resin system is applied.
Bismaleimide resin for microdiameter pultrusion process and preparation method thereof	September 5, 2012/ CN 102167825 B	Nanjing University of Aeronautics and Astronautics	Ren Hua , Xiao Jun , Hu Jingjing , Chen Wenna	The invention discloses a modified bismaleimide resin for a microdiameter pultrusion process The modified bismaleimide resin is prepared from the following raw materials in part by weight: 100 parts of 4,4 '-bismaleimide diphenylmethane, 1 to 30 parts of diamido diphenyl sulfone, 10 to 150 parts of dially bisphenol A and 1 to 50 parts of liquid epoxy resin. The bismaleimide resin has high formingprocessibility and a cured substance has high heat resistance. The invention also discloses a preparation method of the modified bismaleimide resin. The bismaleimide resin with viscosity and activitymeeting a composite material pultrusion process is prepared by prepolymerizing the 4,4 '-bismaleimide diphenylmethane, the diamido diphenyl sulfone, the dially bisphenol A and the liquid epoxy resin by using a high-temperature type radical initiator The reaction is stable;. the process condition is easy to control; byproduct separation is not required in the reaction process; no 'three wastes' aregenerated; and the method is applicable to industrialized production.
Pultrusion process	December 15, 2011/ US 20110306718 A1	Basf Se	Dietrich Scherzer, Andreas Wollny, Simone Schillo	The present invention relates to an improved pultrusion process for producing semifinished products based on polymers, in particular polyesters or polyamides, which comprises adding reactive chain extenders during the process of saturation (impregnation) of the fibers.
Pultrusion process and related article	March 3, 2011/ US 20110052904 A1	Graham Engineering Corporation	Joseph A. Guarriello	A pultrusion article and method for manufacturing the same is disclosed. The article has a core of cured thermoset material and foaming agent. Unidirectional fibers are distributed about the periphery of the article. A shell of cured thermoset material encapsulates the unidirectional fibers, with the shell having a greater density than the core. The core and the shell are bonded together. The article provides increased strength without the use of cross-fibers.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Pultrusion process for production of a continuous profile	February 24, 2010/ EP 2155475 A1	Airbus Operations GmbH	Michael Bechtold	The invention relates to a pultrusion process (known as an 'ADP process') in which a continuous reinforcement profile (11) is formed by canting of at least one prepreg strip (6-9) composed of a fiber-reinforced plastics material. The first shaping of the profile (11) takes place in a preform device (10), which is downstream of a pressure-molding device (12) for final shaping and prehardening. The movement of the profile (11) preferably takes place synchronously with respect to the operating cycle of the pressure-molding device (12) by means of a traction device (14). By using a cutting device (15), it is possible to cut the profile (11) to length and/or to subject edges to subsequent mechanical operations to ensure that correct dimensions are maintained. According to the invention, a continuous {pultrusion) gusset (29) is concomitantly inserted between the prepreg strips (6-9), in a radius region (27) of the profile (11), for example in the region in which the prepreg strips (6 to 9) adjoin one another during the formation of a profile (11) with a vertical web (19) with bilaterally adjacent flanges (17 and 18) (H-shaped cross-sectional geometry), thus filling, in a defined manner, cavities (28) in this region. By virtue of the continuous gusset (29), geometry deviations and/or thickness variations (variations in fiber volume content) in the radius regions (27) are eliminated and the amount of scrap is reduced.
Floating head assembly for a pultrusion process	July 24, 2001/ CA 2169218 C	Stanley Rokicki	Stanley Rokicki	A head assembly for a pultrusion process having a centre line and being substantially fixed to a supporting surface and for putruding pultrudable material, the head assembly comprising a floating adjustable assembly having a front, rear, top, and bottom, and having disposed therewith a pultrusion die having a centre line disposed at the intersection of both the vertical and horizontal planes, said die having a front or entrance, and a rear or exit, the pultrudable material passing from the entrance of the die to the exit of the die and thus substantially forming the finished shape of the pultrudable material, the centre line for acceptable pultrudable material extending within predetermined limits along the centre line of the process as the material passes from the exit of the die, the centre line of the exit of the die always remaining stationary and disposed proximate the centre line of the process, the die being fastened in position with respect to the head assembly by at least one mounting member also having a front, rear, top and bottom, the head assembly having disposed therwith proximate the rear thereof proximate the exit of the putrusion die a fixed frame portion fixed in position with respect to the supporting surface, the at least one mounting member and hence the pultrusion die being moveably affixed (for example pivotable) with respect to the fixed frame portion, the head assembly having disposed therewith at least one adjustment actuator to provide for adjustment of the head assembly and therefore the entrance of the die with respect to the exit of the die, the at least one adjustment actuator being fixed to the supporting surface and affixed with respect to the at least one mounting member and thereby providing the adjustment of the front of the head assembly, wherein should the centre line of the form of the pultrudable material exiting the die be out of line with the pedetermined limits from the centre line of the process the adjustment actuator will upon the operation thereof adjust the position of the entrance of the die with respect to the centre line of the process and the exit of the die by effecting the movement of the front of the at least one mounting member and therefore the front of the die with respect to the fixed frame portion sufficiently until the centre line of the pultrudable material is again substantially in line with and within acceptable limits from the centre line of the process and the exit from the die.

Exhibit 1 depicts patents related to pultrusion process.

Picture Credit: Frost & Sullivan

Back to TOC